000 [114] [311] 165--The "hospitality" of the landscape around the Mulwiya River contradicts Blanco's earlier remark about unproductivity; and the Central Rif itself, in any event, is one of the poorest and most barren regions of Morocco.

166--"Primary instruction", or ta'lim al-awwal, is the basic Qur'anic instruction which the fqih gives young boys in the village mosque, while "secondary instruction", or ta'lim ath-thani, is a step beyond this--post-graduate study, as it were, in the Friday mosque. By this time the amhadar has become a tarib; he can theoretically read and write the Qur'an, and he also becomes versed in the writing of charms and amulets and the sewing of jillabas.

[431] 167--Ma'ruf is a gift of either money or food to the students in the mosque.

168--The most obvious spring in the Asht Marar, Thara Tazzugwakhth or, in Arabic, 'Ain Hamra, which produces the best mineral water in the Rif, even though it only trickles out of the source, is not mentioned.

169--These last three communities are traditionally affiliated with the clan of Imzdurar, not with Asht 'Asim.

170--The Imrabdhen of Wawizaght are also termed Imrabdhen Ya'gubi, and are considered shurfa.

171--Midbuh was from Asht r-Udha; Buhut r-'Asimi, as his name indicates, from Buridh in Asht 'Asim; and 'Allal n Dahu from Asht Mhand.

172--For "anarchy", read "Ripublik".

[616] [578] 173--Of Azru, who later became the head of one of the main tribal liffs in opposition to Hajj Biqqish of Ikhuwanen in Asht 'Asim.

174--Now held at Tizi Usli.

[616] [619] 175--In his earlier years, however, Biqqish only had control of his own liff of Asht 'Asim and Asht 'Aru 'Aisa, while Si Hmid Ubarshan had the rest of the tribe under his thumb.

[613] [616] The dharfiqth of Yinn 'Ari Mqaddim in Aith Yusif of Thimarzga in Aith Waryaghar were Biqqish's in-laws, through the marriage of his daughter Mimuna to Muh n 'Amar jn-Mqaddim (see text); and the liff created between Biqqish and this single lineage of Aith Waryaghar was strong enough for them to support him against 'Abd al-Krim later on; and 'Abd al-Krim, in consequence, burned their houses.

176--Afuzar is on the border of Aith Waryaghar and Igzinnayen, between Asrafil (Thimarzga) on the Waryaghar side and Iharrushen (Asht 'Asim) on that of the Igzinnayen.

[176] [178] 177--The principal saint of the Marnisa. Near the Monday Market of the Aith 'Ammarth is the mosque of Sidi 'Ari n Dawud, where the Aith 'Ammarth all go to take oath; but Sidi 'Ari himself is buried in Marnisa.

178--The date of Biqqish's death is not certain, but probably early 1926. His body was taken to the cemetery at Ikhuwanen for burial.

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perspective. Material traits do not include all of cultural geography, but they do constitute the core of things that the geographer can study systematically.

The thesis of my study of deforestation is that the extent of change can be roughly delimited by historical research and by observation of present trends. In northern Morocco, as elsewhere in the Mediterranean region, the principal agents of deforestation have been (1) domestic and industrial consumption of wood, (2) burning to clear land for cultivation, and (3) destruction of palatable plant material by livestock. There is evidence that each of these agents has been active for centuries. If allowance is made for probable variations in the rate of disturbance, tentative conclusions may be reached as to the extent of change.

For reasons that are painfully evident to all students of Moroccan languages or dialects, correct transliteration is difficult to achieve. Consider the word for "mountain." On French maps it apears as *jebel* or *djebel;* on Spanish maps it is *yebel.* The proper English transliteration of the classical Arabic is *jabal.* But most Moroccans know little of classical Arabic. The usual pronunciation is *jbil,* and this is the way I have written the word. I have tried to transliterate words so that they are intelligible to English-speaking readers. Thus the Maghribi Arabic word for "stream" appears as *wad,* not as *oued* or *uad.* Shawen is substituted for Chauen or Xauen, and Wezzan for Ouezzane. The variant spellings of French and Spanish cartographers are listed in the Appendix.

The field work for this study was carried out from November, 1955, to May, 1957, under the sponsorship of the Ford Foundation. I wish to acknowledge my gratitude to that institution for its support. I am grateful to many Moroccans who helped me to understand their land and culture. Special mention should be made of my frequent traveling companions, Muhammad Miqqi of Ktama and Muhammad ben Hmid l'Arbi of Aith Seddath. I am indebted also to Charles Sauvage of the Institut Scientifique Chérifien for assistance in the identification of plants.

Since returning to the United States, I have profited from correspondence with David M. Hart. Mr. Hart was engaged in ethnological field work in the Rif from 1953 to 1955 and has since returned to Morocco for more extensive research. I am indebted to him for notes on many aspects of Moroccan culture, and especially for his advice on transliteration. The reader with prior knowledge of the literature on northern Morocco will be aware that I have derived great profit from study of the pioneer work of Carleton S. Coon. The illustrations of clothing and house types for chapters i and v were made from my collection of photographs and field sketches by Iris Neff and Jacques Lemieux.

Finally, I wish to express appreciation for the encouragement given to this undertaking by my teachers at the University of California. A preliminary version of this study was prepared as a doctoral dissertation in geography under the supervision of Professors Carl O. Sauer, Melvin M. Knight, and James J. Parsons. The present work has profited from the criticism of Professors John Leighly, Erhard Rostlund, and Clarence J. Glacken.

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CHAPTER V

SETTLEMENT MORPHOLOGY

NORTHERN MOROCCO is primarily a rural country. In the 1950 census of the Spanish protectorate, 2,954 places are listed as nuclei of settlement, but more than half of them had less than 200 inhabitants.[1] In 1953 the total population of the protectorate was estimated to be 1,026,056 persons, of whom 788,810 were rural. In the whole of Morocco, rural tribesmen probably account for more than 75 per cent of the population.

Since population density can be calculated only for tribal territories, detailed analysis of distribution is difficult. Nevertheless, it is clear that some areas are much more densely settled than others. The greatest rural density is found on the Atlantic and Rifian littorals, and the lowest in the central highlands and on the semiarid eastern plains. On the terraces and hills of the Atlantic littoral the density of population varies from 50 to 80 persons per square kilometer. In the territory of the Bani Huzmar, which is dominated by karstic mountains, the density drops to 40 persons per square kilometer. Actually, most of this tribe is settled along the base of the limestone range, close to the line of springs. In the Sanhajan highlands the fertile valley of Taghzut, with 85 persons per square kilometer, contrasts with the higher and more rocky terrain of Aith Khannus, with only 22 persons per square kilometer. On the parched plains of Garet, population density drops to about 12 persons per square kilometer. It is surprising to find high density in Gal'aya and the core area of the Rif, for these areas suffer from frequent droughts. Aith Wariyaghar has 65 and Thimsaman 72 persons per square kilometer. The Gal'ayan tribe of Imazujen, with 125 persons per square kilometer, has the highest population density in northern Morocco.[2] Before the recent rebellion these densely settled areas supplied as many as 30,000 laborers annually for the French farms in Algeria. The causes and consequences of emigration will be considered in chapter vi.

The high density of population in Bdor, Amar, and Mzura is encouraged by the small areas of these tribes. Land is available in neighboring territories, but no family wants to sell its land to "foreigners." Tribesmen from the more crowded areas often remark on the underdeveloped appearance of the Jbalan and Ghmaran hills. Tribesmen of the Rif and Gal'aya would gladly work many slopes which the Jbalans and the Ghmarans regard as marginal.

URBAN FORMS AND FUNCTIONS

When the French began their occupation in 1912, Marshal Lyautey declared that European settlements should be set apart from native centers. French settlements grew beside most native cities, but the two forms of urbanization did not merge. The Spanish were less respectful of Moroccan culture, but the urban pattern in the Spanish zone was one of juxtaposition rather than mingling, and the line between European and native communities was never erased. Native cities

[1] *Anuario estadístico, 1952–53* (Madrid: Instituto Nacional de Estadística, 1955), p. 39.
[2] Figures from J. Cabello Alcaraz, *Apuntes de geografía de Marruecos* (Tetuán: Editora Marroquí, 1951), pp. 119–121.

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surplus food for lean years. Many tribesmen, especially the Rifians and the inhabitants of Garet and Gal'aya, live under the constant threat of famine. Every failure of the cereal crop causes great suffering. Even with resources developed to the limit, these areas would still be unable to provide full employment or full nutrition for their expanding populations. The rate of population growth through-

TABLE 5

VALUE OF TRADE AT REGIONAL MARKETS IN 1949

Market	Volume of trade (pesetas)
Jbala—Lukkus	
Sebt Bani Said	43,000,000
Tlata Jbil Habib	89,000,000
Jema Zinat	80,000,000
Khemis Anjra	60,000,000
Tnine Sidi Yamani	117,000,000
Tlata Reisana	102,000,000
Sebt Bani Gurfat	82,500,000
Arba Aicha	68,500,000
Ghmara—Sanhaja as-Srair	
Had Bani Dercul	57,000,000
Tlata Bani Hmid	84,000,000
Tlata Ktama	65,000,000
Arba Targist	166,000,000
Rif—Garet—Gal'aya	
Tlata Aith Hadhifa	88,000,000
Arba Turirth	122,000,000
Tnine Aith Bu Ayyash	109,000,000
Tnine Aith Ammarth	65,000,000
Arba Aith Sidar	105,000,000
Khemis-Jema Driuch	138,000,000
Khemis Ain Zorah	107,000,000
Had-Tlata-Khemis Thimsaman	240,000,000
Tlata Ikibdhanen	104,000,000
Had Jbil Arruwi	101,000,000
Tnine-Khemis Thafarsith	78,000,000
Khemis Zaio	90,000,000

SOURCE: J. Caballo Alcaras, *Apuntes de geografía de Marruecos* (Tetuán: Editora Marroquí, 1951), pp. 167-169.

out northern Africa must be described as alarming. In Morocco the mean annual increase is 1.5 per cent. This rapid increase creates serious economic problems, all the more so on account of the youth of the population, of whom 41 per cent are less than fifteen years old.[a] The spread of preventive medicine and the persistence of such social practices as early marriage and easy repudiation of sterile wives accentuate this trend. The cultivated area of northern Morocco has doubled in the last three decades,[b] but many tribes still find it impossible to grow enough food.

[a] Nevill Barbour, ed., *A Survey of North West Africa (the Maghrib)* (London and New York: Oxford University Press, 1959), p. 81.

[b] *Anuario estadístico, 1952–53*, p. 91, cited in note 1.

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Chapter VII

EFFECTS OF SETTLEMENT ON THE LAND

121 311 Evidence of deforestation has already been considered briefly. In chapter ii the effects of burning and browsing were mentioned parenthetically in discussing the distribution of forest and scrub. Now that man's activities have been described, the discussion can be resumed.[1]

Historical Evidence

175 311 When the Emperor Claudius created the province of Mauritania Tingitana in A.D. 46, timber resources were nearly exhausted in the eastern Mediterranean basin. The cedars of Lebanon had been retreating since the time of King Solomon. Homer refers to "tall pines and spreading oaks" on the now virtually barren island of Sicily.[2] Plato, in the fifth century B.C., deplores the destruction of the forests in Greece,[3] and a century later Theophrastus complains that the supply of ship timber is limited.[4] In Pliny's time the thuya forests on Mount Ancorarius were already exhausted.[5] At the dawn of the Christian era, Roman ships were sailing as far away as the Caucasus ports to obtain timber, and Roman architecture eventually had to be modified to compensate for the scarcity and increasing price of wood. Large quantities of wood were needed to heat baths, and trees were cut everywhere for charcoal. Cork and tanners' bark were persistent items of trade. In both the Roman and the Carthaginian realms, perhaps the greatest wood-devouring industry was shipbuilding. As Miss Semple suggests, "A multitude of fishing smacks, naval vessels, merchant ships, and coastwise transportation boats kept up the demand for fir, pine, cedar, and minor woods which entered into their construction."[6] The coniferous forests were further depleted by the steady demand for pitch, resin, and tar. It would be rash to make sweeping generalizations on the basis of a few references after the lapse of centuries; yet it may be asserted that deforestation was evident in classical times, especially in the areas of Roman and Carthaginian influence, and that no forested area accessible to lumber merchants was ignored.[7]

In the time of Homer and Hesiod the Moroccan mountains were still confused with the peak of Tenerife, of which some indistinct knowledge had been gained from Phoenician sources.[8] The references to Atlas cedar in Latin literature usually refer to forests in the more familiar province of Numidia. According to Pliny,

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[1] For additional illustrations, see M. W. Mikesell, "Deforestation in Northern Morocco," *Science*, 132 (1960), 441–448.

[2] *Odyssey*, IX; *Iliad*, XII, XVI, XX.

[3] *Critias*, 111 A–D, trans. A. J. Toynbee in *Greek Historical Thought* (New York: Mentor Books, 1952), p. 146.

[4] *Enquiry into Plants . . .*, IV, 5.

[5] *Natural History*, XIII, 15. Most authorities place Mount Ancorarius in the Ouarsenis Massif of Algeria. Paul Boudy, *Economie forestière nord-africaine* (Paris: Larose, 1948–1955), I, 223.

[6] E. C. Semple, *The Geography of the Mediterranean Region: Its Relation to Ancient History* (New York: Henry Holt, 1931), p. 282.

[7] H. C. Darby, "The Clearing of the Woodland in Europe," in W. L. Thomas, Jr., ed., *Man's Role in Changing the Face of the Earth* (Chicago: University of Chicago Press, 1956), pp. 183–216.

[8] *Cf.* George Rawlinson's annotation of Herodotus, *History*, IV, 184 (London: J. M. Dent and Sons, 1910); and R. Thouvenot, "La connaissance de la montagne marocaine chez Pline l'Ancien," *Hespéris*, 26 (1939), 113–121.

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beams of Numidian cedar were used in the temple of Apollo at Utica.[9] Strabo describes Mount Abyla (Jbil Hacho) on the Ceuta promontory as being clothed with a mantle of great trees.[10] This specific reference is of major interest, for now only a few clusters of Aleppo pine appear on that promontory. The description of forest at Cape Cantin, near Safi, in the periplus of Hanno is significant, also, for no such description could be recorded today.[11] It is known that the African provinces contributed wood to the Roman baths, and it may be inferred that some of that wood came from Mauritania. Thuya beams were imported for the roofs of temples, palaces, and other fine buildings, and the same wood was preferred for cabinets and other furniture.[12] The pine and thuya of the Rif probably were exploited in shipbuilding, and there would have been a demand for fuel and lumber at each of the Tingitanian settlements.

The first Arab invasion of Morocco in A.D. 648 and the great immigration of bedawin tribes in the eleventh century mark the beginnings of two trends that have an important bearing on this discussion. The first Arab invaders were pious and learned men who sought to build an urban civilization comparable to that already established in the Muslim heartland. In each of the new cities wood was needed for building, for fuel, and for a hundred other domestic and industrial purposes. The great demand for tanbark at Marrakech, Fez, Salé, and Tetuán soon resulted in the destruction of large stands of holly oak and cork oak. Planks of cedar were needed for city gates, and beams of cedar or thuya were placed in mosques and palaces. Slender riparian trees were used in smaller structures, and charcoal braziers burned in every home. By the end of the tenth century the Moroccan cities had become "devourers of wood."[13]

Many authors, seeking a dramatic explanation of Moroccan deforestation, attribute most of the adverse change to the bedawin; at least one author refers to their "hatred of trees."[14] Ibn Khaldun noted the effects of the invasion of northern Africa by the Bani Hallal and Bani Soleim: "When the Arabs [i.e., bedawin] conquer a country, ruin quickly descends upon it"; after three hundred and fifty years of unrestricted nomadism in his native Tunisia, "ruin and devastation" still prevailed.[15]

Pastoral destruction accelerates very rapidly, for the havoc wrought by overgrazing lies not only in its destruction but also in its prevention of new growth. But it is seldom possible to distinguish one among the several causes of deforestation. There is something appealing in the thought that the Vandals or the bedawin "destroyed" the north African forest, just as there is in the notion that the Mesopotamian irrigation system was "ruined" by the hordes of Hulagu Khan.

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[9] *Natural History*, XVI, 40.

[10] *Geography*, XVII, 3.

[11] For an English translation, see B. H. Warmington, *Carthage* (London: Robert Hale, 1960), pp. 62–64.

[12] Cf. Vitruvius, *Architecture*, II, 4; and Pliny, *Natural History*, XVI, 231, XXXIII, 146.

[13] Jean Despois, *L'Afrique du Nord* (Paris: Presses Universitaires de France, 1949), p. 84.

[14] A. Bernard, *Afrique septentrionale et occidentale* (Paris: Armand Colin, 1937–1939), I, 65.

[15] Charles Issawi, trans., *An Arab Philosophy of History: Selections from the Prolegomena of Ibn Khaldun of Tunis (1332–1406)* (London: John Murray, 1950), pp. 54–58. Cf. Boudy's comment, *op. cit.*, I, 228; cited in note 5: "C'est incontestablement de cette période que date la grande déforestation du pays, résultat inéluctable des incendies répétés et du pâturage sans mesure." In "Le déboisement de l'Afrique du Nord," *Rev. des Eaux et Forêts*, 79 (1941), 471–487, Paul Buffault also blames the bedawin, but his argument is weakened by use of discredited notions of climatic change.

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Both of these alien invasions merely accelerated processes of destruction or decay that had been going on for a long time.

Several of the Arab chroniclers refer to woods in areas that are now deforested. The celebrated text of the seventh century in which northern Africa is described as a land of "continuous shade" is doubtless exaggerated,[1] for the Maghrib would appear to be lush and verdant even today after a long trip through the deserts of Egypt and Libya. Later accounts are more specific, and several of these refer to northern Morocco. In the latter half of the eleventh century Al-Bekri describes an "extensive forest" near Qasr al-Awwal (Ksar as-Srair).[2] Today this area is covered by a shrub formation, interrupted only by scattered clumps of cork oak. In the middle of the twelfth century Al-Idrisi describes Ghmara as a "mountainous and wooded" land.[3] A generation later another author refers to forest in the Ghmaran mountains, and indicates that wood from this forest is used in the construction of boats.[4] In the fifteenth century Al-Ansari found an "abundance of trees" near Ceuta, where forest is now limited to a few stands of cork oak and Aleppo pine.[5]

In the sixteenth century the forests on the Rifian coast began to attract the attention of the Spanish. Moorish pirates had been raiding the Andalusian coast and it was virtually impossible for an unarmed ship to sail through the Strait of Gibraltar. The distress of the Spanish resulted not only from the daring of the Moors but also from the fact that the latter's boats were astonishingly fast and maneuverable. Contemporary accounts praise the "alerce" wood used in the Moorish boats and rate it higher than Spanish oak or pine. Opinions differ as to the identification of this wood, but descriptions of its distribution and properties strongly suggest the Barbary thuya (*Callitris articulata*).[6] In 1505 an agent of Fernando el Católico suggested that an expedition should be directed against the Moroccan coast at Peñón de Vélez because large quantities of alerce were to be found there and not elsewhere on the coast.[7] The latter assertion is almost certainly an error, for thuyas are still scattered over most of the Rifian littoral. At this time the interest of the Spanish seems to have been defensive, but they may have been interested in alerce as a source of timber for their own fleet. In the days of the Armada, Spain looked as far away as the Baltic for suitable timber.[8]

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[1] E. Lévi-Provençal, "Un nouveau récit de la conquête de l'Afrique du Nord par les arabes," *Arabica*, 1 (1954), 40.

[2] Al-Bekri, *Description de l'Afrique septentrionale* (Algiers: Adolphe Jourdan, 1919), p. 306.

[3] Al-Idrisi, *Description de l'Afrique et de l'Espagne* (Leiden: E. J. Brill, 1866), pp. 203–204.

[4] J. Vernet Ginés, "Marruecos en la geografía de Ibn Sa'id al-Maghribi," *Tamuda*, 1 (1953), 255.

[5] E. Lévi-Provençal, "Une description de Ceuta musulmane au XV^e^ siècle," *Hespéris*, 12 (1931), 145–176.

[6] After initially labeling alerce as thuya, T. García Figueras, *Miscelánea de estudios históricos sobre Marruecos* (Larache: Editora Marroquí, 1949), pp. 143–148, suggests that this name is related to *ars* (Arabic for "cedar"), an opinion shared by J. Corominas, *Diccionario crítico etimológico de la lengua castellana* (Bern: Francke, 1954). But it is unlikely that the cedar ever grew on the Mediterranean coast. Actually, there is little to choose between *ars* (cedar) and *ar'ar* (thuya) as possible roots of "alerce." The Latin *Larix* (larch) seems more plausible, but there are no deciduous conifers in Morocco.

[7] The reference is to "madera de los alerces, que los hay en Vélez y muchos y no en otra parte de la costa." For the complete text, see M. Jiménez de la Espada, *La guerra del moro a fines del sigol XV* (Ceuta: Imprenta Africa, 1940), p. 16.

[8] R. G. Albion, *Forests and Sea-Power* (Cambridge, Mass.: Harvard University Press, 1926), p. 183; Hellmuth Hopfner, "La evolución de los bosques de Castilla la Vieja en tiempos históricos," *Estudios Geográficos*, 15 (1954), 415–430.

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A number of references to vegetation in northern Morocco appear in the journals of Leo Africanus.[26] In his introductory account of northern Africa the mountains of Barbary are described as "woody on all sides" and as being "replenished with woods and lofty trees."[27] But on the eastern frontier of Barbary, close to Libya, he found "certain barren hills destitute of trees, upon the lower parts whereof grow nothing but unprofitable thorns and shrubs."[28]

Leo's account of the "Kingdom of Fez" reveals his careful observation during extensive travels in northern Morocco.[29] "The Rif Mountains," he notes, are "replenished with most beautiful and straight trees." On the banks of Wad Lukkus he found "huge and solitary woods haunted with lions and other wild beasts." In 1562 a Portuguese attempt to supply the fort at La Graciosa was thwarted, according to Leo, when the Moors cut down "all the woods adjoining the river," causing it to be "choaked and stopped up with great trees." In this context it would seem that Leo refers to riparian forest, but he may be describing an extensive stand of cork oak. This forest did not extend over the entire Atlantic littoral, for he later notes that Arcila "sustaineth great want of wood" because it "standeth almost ten miles from the mountains." Then as now, the people of Arcila imported charcoal from the cork forests south of "Larais" (Larache).

Leo's description of Anjra shows an alertness to change. "In times past," he notes, the mountains of Anjra "greatly abounded with woods, which, being cut down by the inhabitants, were sent to Casar [Ksar as-Srair] for the building of ships, which at that time had a great fleet belonging thereunto." This passage seems to imply that ships were no longer being built or that shipbuilding had declined. A further implication might be that shipbuilding had declined because suitable timber had become scarce. If so, the depletion of the forest must have taken place between the thirteenth and sixteenth centuries.[30]

Proceeding eastward on the Mediterranean coast, Leo stopped at "Terga," a few kilometers beyond Wad Lao and noted "not far from this town" an "abundance of wood upon the ragged and cold mountains." A similar observation is recorded at "Velles de Gumera" (Vélez de la Ghmara): "Upon the mountains grow great store of wood, very commodious for the building of ships and of galleys"; and he adds that the inhabitants of these mountains "are almost wholly employed about carrying of the said wood from place to place."[31] The reference to lumber trade is not surprising, for the Sanhajans probably carried cedar planks from market to market long before the sixteenth century; but it is surprising to find a suggestion that the mountain tribes were "almost wholly employed" in this trade.

The next account refers to "Ielles," a village located on the coast between Vélez and the bay of Alhucemas. The mountains south of this place are described as being "full of pine trees," and Leo found "great store of wood" in the moun-

[26] Leo Africanus, *The History and Description of Africa* (London: Hakluyt Society, 1896).
[27] *Ibid.*, I, 168–169.
[28] *Ibid.*, I, 173.
[29] *Ibid.*, II, 494–539, Hakluyt edition. The quotations to follow are taken from Book 3 of the narrative.
[30] Vernet Ginés, *op. cit.*, in note 19.
[31] In regard to the same place, Mármol (who may have copied Leo) refers to "buen aparejo de madera en las sierras de alrededor, donde hay muchos árboles, alcornoques y alerces para hacer navíos." Luys del Mármol Carvajal, *Descripción general de Africa* (Granada and Málaga, 1573–1599), III, chap. 62.

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tains of the upper Nkour. The same expression is applied to the mountains on the route between Vélez and Fez (probably the Sanhajan highlands), and to "Mount Seusaoen" (i.e., Shawen, probably Jbil Tisuka). Leo's account of the eastern sector of northern Morocco is very different. The plains of Garet are described as a desert, and the lower Moulouya Valley as being "unpleasant and dry," with "no water but that of the river Muluia."

Accounts of forest in the Rif highlands are to be expected, but it is surprising to find repeated references to forest on the Mediterranean coast. Similar accounts appear in the works of Arab writers of the twelfth and thirteenth centuries, and Strabo describes the Ceuta promontory as being clothed with a mantle of great trees. The frequent mentions of trees near Ceuta suggest a profound modification of vegetation in subsequent years. Accounts of shipbuilding and lumber trade indicate some commercial logging; the retreat of the forest near Ksar as-Srair, Ceuta, and Vélez might have been a direct result of these activities. Leo's reference to "great want of wood" at Arcila suggests that the hills and marine terraces of the Tahgier-Tetuán-Arcila triangle had been cleared before his time, but extensive woods still existed in the basin of Wad Lukkus. His evaluation of the Moulouya Valley may have been prejudiced by previous exposure to more verdant areas, but "desert" does not mean forest, or even a rich formation of scrub.

Agents and Processes of Change

In northern Morocco today, the most important agents of deforestation are: (1) domestic and industrial consumption of wood, (2) burning to "improve" pastures and to clear fields for cultivation, and (3) destruction of palatable plant material by sheep and goats. These processes are evident even to the casual observer, but it is difficult to determine their relative importance. Despois believes that the principal causes of deforestation have always been the need for fuel and new land to till.[11] Braun-Blanquet describes the Mediterranean garrigues as "zoöbiotically conditioned communities."[12] Kuhnholtz-Lordat is convinced that the greatest agent of deterioration has been fire.[13]

Each emphasis is supported by abundant evidence, but it may be doubted whether the several causes of deforestation can be treated independently. A series of fires, if not too closely spaced, may not result in deforestation, but burning followed by heavy pasturing inevitably does. Most of the broad-leaf trees in northern Morocco reproduce themselves from shoots after being burned or felled, but in areas overrun by goats the shoots are browsed down and forest degenerates to scrub. In tangled brush formations it is often difficult to tell whether the main destructive agent has been fire, domestic animals, or man.

Consumption of Wood

Although kerosene lamps burn in many Moroccan homes, charcoal and wood are the only important domestic fuels.[14] Butane and electrical appliances are

[11] Despois, *op. cit.*, p. 84, cited in note 13.

[12] J. Braun-Blanquet, *Pflanzensoziologie: Grundzüge der Vegetationskunde* (2d ed., Vienna: Springer, 1951), p. 371.

[13] G. Kuhnholtz-Lordat, *La Terre incendiée: essai d'agronomie comparée* (Nimes: Editions de la Maison Carrée, 1939), *passim*.

[14] Anthracite of excellent quality has been mined at Djerada south of Oujda since 1931, but

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313 The great wooden gates that used to guard the openings of every city wall
648 demonstrate the importance of the lumber trade. Only fragments of these gates
171 still exist, but it is certain that most of them were made of cedar. Logging operations were greatly expanded by the Spanish after the Rifian tribes had been pacified. It is not an exaggeration to say that the mineral deposits and cedar forests of northern Morocco were the only compensations for Spain's investment in colonial prestige. Reliable estimates of the amount of timber cut since the beginning of the protectorate cannot be found, possibly because the Spanish claimed to be conserving and restoring the forests in their zone. With the backing of military force, the Spanish were able to exercise some control over cutting by the native population, but their own work proceeded without interruption or apparent regulation. Spanish officials point out that the forests being exploited were private property and that the forestry service was concerned only with public domain.

In 1956 sawmills operated throughout the year at Tetuán and Targist, and during the summer months trucks heavily loaded with cedar logs could be seen on every mountain road. The fir forests on Jbil Tisuka and Jbil Leshab had not yet been heavily logged when Spanish "protection" came to an end, but the deciduous oaks on Jbil Buhashim had been cut in quantity for use as railroad ties. These operations may have been a brief chapter in the history of the Moroccan forest, but it is probable that the Spanish, with modern equipment, cut more trees in a decade than the local tribesmen could destroy in a century. The effects of Spanish logging are strikingly evident in the Sanhajan highlands, especially on Adrar Dahdoh, Adrar Tidighin, and Adrar Tizi Ifri.

313 This harsh judgment applies only to the exploitation of cedar and the decidu-
171 ous oaks. A modest amount of reforestation was undertaken. A plantation of
[185] *Eucalyptus* was established north of Larache; Aleppo pines were planted near Rincón, Alhucemas, Nador, and Melilla; and an effort was made to prevent premature stripping of the cork oak.[32]

Profiting from long experience in Algeria, the Service des Eaux et Forêts carried out an elaborate program in French Morocco. The system advocated and partly enforced was based upon periodic and progressive thinnings, which were intended to reconcile the interests of the tribesmen with good forestry practice. If effectively enforced, this method would have permitted the production of fuel without waiting for the normal age of exploitation, and would have improved pastoral conditions by facilitating the movement and supervision of livestock.[33]

314 Tannin is extracted from the roots and bark of all the Moroccan oaks, and
171 this operation frequently results in mutilation or death. The cork oak is especially vulnerable, for tannin is scraped from the delicate inner bark immedi-
311 ately after the corky tissue has been removed. Complete girdling destroys trees, and death may result if more than half of the circumference is damaged.[34] The tanners of Marrakech have been responsible for extensive deforestation in the

[113] [32] The program planned by the Spanish forestry service is described in González Vázquez, *op. cit.*, pp. 97–185, cited in note 34; and J. Ruiz de la Torre, *La vegetación natural del norte de Marruecos y la elección de especies para su repoblación forestal* (Larache: Centro de Investigaciones Forestales, 1956).

[113] [33] For a brief account of French management, see J. P. Challot, "L'homme et la forêt marocaine," *Rev. des Eaux et Forêts*, 84 (1946), 233–261.

[34] Boudy, *op. cit.*, II (fasc. 1), 47 ff., cited in note 5.

7: Mikesell K-4,5 (1955-1957) 1961 MX3 Rif MX3

High Atlas. Deforestation can be traced also to the tanners of Fez and Tetuán.[a] The tanners' guild in Fez goes back to the ninth century, when master tanners gathered at this site from Córdoba, Qayrawan, and distant Iran. Fez leather was once exported as far away as Baghdad, and shoes went to Egypt until the present century. During the peak years of production, Fez craftsmen tanned about 500,000 skins a year. The descendants of the original immigrant craftsmen are still busy making handbags, slippers, and other articles for the tourist and export trade.

It is not surprising that *Quercus Ilex*, an important source of tannin, should now be rare in the hills near Fez and Tetuán. There is good reason to believe that the holly oak once covered these hills. One well-informed botanist asserts that the primordial cover of the limestone mountains south of Tetuán probably was a "climax" forest of holly oak.[b] In Gal'aya and the eastern Rif, careless stripping of the bark of *Rhus pentaphylla*, a source of red dye, destroys many trees; "Morocco leather," a trade name in bookbinding, is customarily made from goatskin tanned with sumac.

Effects of Burning

In the eastern Rif the plant cover is usually too sparse to maintain a fire, and on the Atlantic littoral there is little land left to clear. But between these areas is a large zone covered with forest or scrub that must be burned before the land can be plowed. Some attempt is usually made to control the spread of fire, but conflagrations develop when tinder-dry shrubs are fanned by brisk winds. Fire is employed also for the "improvement" of pasture, for increased blossoming ("bee pasture"), and probably for the mere pleasure of burning or out of carelessness.[c]

The importance of pastoral fires has been emphasized by most students of the Mediterranean landscape,[d] but in northern Morocco fires set to clear away noxious shrubbery or to facilitate movement of stock are less important than agricultural fires. Pastoral fires are neither necessary nor desirable where there are goats, for these animals thrive on woody browse and can break through the thickest scrub. Sheep outnumber goats only in the drier eastern sector, where impenetrable formations are rare. For every fire set to "improve" pasture, probably more than ten are set to prepare new fields for plowing.

Whatever its cause, fire is a major agent of deforestation. The difficulty is that there are many kinds of fires: quick fires that run over a thin mantle of vegetation, great conflagrations that consume thicker formations, fires that remain close to the ground, fires that extend to the crowns of trees. It makes a great deal of difference whether fires recur after five or after twenty-five years. Moreover, the important factor may be not the fire itself but what happens to an area after it has been burned.

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[a] R. le Tourneau, L. Paye, and R. Guyot, "La corporation des tanneurs et l'industrie de la tannerie à Fès," *Hespéris*, 21 (1935), 167–240; A. Joly, "L'industrie à Tétouan," *Archives Marocaines*, 8, 15, 18 (1906–1912).

[b] J. Ruiz de la Torre, *El matorral en Yebala (Marruecos español)* (Madrid: Instituto de Estudios Africanos, 1955), pp. 26–27, and the map showing the "natural area" of *Quercus Ilex*.

[c] H. Marc, *Notes sur les forêts de l'Algérie* (Paris: Larose, 1930), p. 396, lists the causes of serious forest fires from 1886 to 1915 as "accidents" (8 per cent), "imprudence" (32 per cent), "intentional" (23 per cent), "unknown" (37 per cent).

[d] G. Kuhnholtz-Lordat, "Influence des feux pastoraux dans la région méditerranéenne," *Jour. d'Agriculture Tropicale et de Botanique Appliquée*, 3 (1956), 785–791.

7: Mikesell K-4,5 (1955-1957) 1961 MX3 Rif MX3

372 Plants that are somewhat resistant to fire or are stimulated to multiply and
137 reproduce by fire have been called pyrophytes.[44] There are many kinds of pyro-
311 phytes, for resistance to or stimulation from fire may be achieved in several ways. The cork oak could be called a pyrophyte of passive resistance, for it is protected by thick insulating bark. Plants that send out new shoots after their aerial organs have been partly or completely destroyed might be described as pyrophytes of vegetative reaction. Budding may take place above ground, as in the thuya, or below ground, as in the kermes oak, palmetto, madrone, and numerous Mediterranean shrubs. Trees that cast deep shade (e.g., undisturbed holly oaks) could be termed pyrophytes of indirect resistance. Finally, some trees and shrubs that seed heavily and grow rapidly (e.g., Aleppo pine and species of *Cistus*) might be described as social pyrophytes.

372 This classification, derived from the pioneer work of Kuhnholtz-Lordat, has
114 much to recommend it,[45] but, like all classifications, it has some faults. The passive
137 resistance of the cork oak depends upon the lapse of time since the last stripping
311 of the bark. Pyrophytes of vegetative reaction may be destroyed if fires recur in rapid succession. In northern Morocco it is hard to think of a good example of indirect resistance. Some stands of cork oak and holly oak have shaded floors and sparse underbrush, but during the dry season such formations may be inflammable. Again, although the Aleppo pine is an excellent pioneer, it may be exterminated if fires recur in rapid succession or if the young shoots are browsed.

372 Recurrent burning thus favors some plants and discourages others. Continu-
137 ous repetition of brush fires produces communities rich in geophytes and thero-
311 phytes. In much of northwestern Morocco, species of *Cistus* are the first shrubby pioneers.[46] They soon collect in extensive clumps, but die out after ten to fifteen years if not burned again. Large areas in Jbala and Ghmara, now covered with *Cistus monspeliensis*, *C. albidus*, and *C. ladaniferus*, probably were once covered with forests of cork oak or holly oak. Fires usually do not destroy the aerial organs of trees protected by thick bark, but the mortality rate rises sharply immediately after the bark has been stripped.[47]

When aerial organs are destroyed, both cork oak and holly oak reproduce from shoots. An occasional fire may even serve to regenerate a senile forest. But extreme care must be taken to prevent further destruction, for *Cistus*, *Erica*, and other heliophilous shrubs spread over the surface as soon as more light reaches the ground. Since the expanding secondary growth is highly inflammable, this process increases the danger of recurrent fires.[48] After several fires, the mesophytic plants are replaced by species more xerophytic as well as more heliophilous, indicating a change to drier soil conditions.[49]

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[44] Kuhnholtz-Lordat, *La Terre incendiée*, *passim*, cited in note 32.

[45] *Ibid.*, pp. 43 ff.

[46] Because of its rapid growth and abundant crop of seeds, *Cistus* has been used in California (113) to protect denuded slopes. Gustaf Juhren, "The Use of *Cistus* in Erosion Control," *Lasca Leaves*, Spring, 1956, pp. 26–29.

[47] See also Boudy, *op. cit.*, I, 663 ff., cited in note 5; and A. Dugelay, "La remise en valeur des forêts de chênes-lièges incendiées," *Rev. Forestière Française*, November, 1951, pp. 687–694.

[48] Boudy, *op. cit.*, I, 649, describes *Erica arborea* as an "élément ignicole par excellence."

[49] On the effects of fire in similar environments, see A. W. Sampson, *Plant Succession on Burned (113) Chaparral Lands in Northern California* (Berkeley: California Agricultural Experiment Station, 1944); R. S. Adamson, *The Vegetation of South Africa* (London: British Empire Vegetation Committee, 1938); W. B. Turrill, *The Plant Life of the Balkan Peninsula* (Oxford:

7: Mikesell K-4,5 (1955-1957) 1961 MX3 Rif MX3

The main difference between the effects of fire in broad-leaf forests and in coniferous forests is that the latter, with the exception of the Barbary thuya, do not reproduce by coppice shoots. The resinous bark of maritime and Aleppo pines is highly inflammable, and since neither tree reproduces from shoots, burning is usually fatal. Yet both species, especially the Aleppo pine, are pyrophytes. Indeed, the presence of a large number of pine seedlings is a sure indication of recent burning. Both species produce abundant seed, and proliferation is encouraged by the destruction of competitive growth. If fifteen or more years have elapsed since a fire, the seedlings reach maturity and the ground is again littered with seeds; but recovery is thwarted by more frequent fires.

Little is known of the effects of fire on the Moroccan fir, but it is probably unimportant as an agent of deforestation. The three main stands of fir grow on the highest slopes of limestone mountains, where there is little underbrush. Furthermore, these mountains do not have sufficient surface water to support permanent human settlement. Goats driven to the mountains from the lower slopes have destroyed many seedlings, but there is little evidence of destructive forest fires. Nor is there evidence of destructive fires in relatively undisturbed stands of cedar. Such forests have little underbrush to serve as kindling, and the cedar itself does not burn easily. But fires may be serious where cedar forests have been invaded by secondary growth. Most of the shrubs common in open stands of cedar—*Cistus, Daphne, Genista, Cystius, Thymus,* and *Halimium*—are highly inflammable. Occasional fires followed by long periods free of disturbance generally do not cause deforestation, but deforestation results when seedlings are destroyed before they can produce seed. The critical interval is disadvantageously long, for the Atlas cedar does not produce abundant seed until it is forty to fifty years old.

Destruction by Domestic Animals

It would be hard to overemphasize the destruction wrought by grazing and browsing. More than half a million sheep and over a million goats are maintained in this zone. These figures are impressive, but the striking fact is that so large a number of animals are maintained by sedentary farmers. No tribe in northern Morocco is nomadic, and only the Ulad Stut and Aith Bu Yihyi practice transhumance. The main types of pastoral disturbance are well described by Braun-Blanquet.[36] Heavy pasturing causes: (1) withdrawal of large quantities of plant matter, (2) mechanical damage to plants by grazing, browsing, and trampling, (3) selective destruction of desired plants, (4) introduction of nitrophilous communities, and (5) alteration of micorelief.

The few cattle and camels kept in northern Morocco probably are not important agents of deforestation. Both animals are used almost exclusively for draft purposes, and few villages can afford to maintain more than one team. Authorities disagree on whether sheep have been significant factors in the process of deforestation. Most of the sheep in northern Morocco are in the drier and warmer parts of the zone, i.e., Garet and the eastern Rif. Woody plants are too

Clarendon Press, 1929); and B. O. Coventry, "Denudation of the Punjab Hills," *Indian Forest Records,* 14 (1929), 49–78.

[36] Braun-Blanquet, *op cit.*, pp. 367–368, cited in note 31.

7: Mikesell K-4,5 (1955-1957) 1961 MX3 Rif MX3

233 311 tough and massive to be adversely affected by grazing, but sheep can destroy shoots and seedlings, particularly those of the resinous trees.[a] The presence of monotonous formations of *Stipa tenacissima* in the lower Moulouya Valley and on the Algerian Hauts-Plateaux probably indicates overgrazing, for a history of excessive grazing may be inferred wherever hard tussock grasses have replaced more palatable growth.

Where goats are numerous, deforestation is accelerated, for no hillside is too steep to daunt this very agile creature, and few plants escape its voracious appetite (pl. 8, *a*). In Arcila, goats scale the nearly vertical Portuguese walls, and in the Sous Valley they climb into *Argania* trees. Not content with the grazing of grass, goats tear it up by the roots. When woody browse is exhausted, the soil itself is grazed in an attempt to get at the seeds of grasses and other plants. It is not surprising that the goat should be described as an "ecologic dominant,"[b] and that many naturalists would like to see it become extinct, except in zoos.[c]

[372] The most serious deforestation occurs when heavy browsing follows burning. Premature browsing or grazing results in the destruction of seedlings before they can produce a new crop of seeds. The French forestry service has ruled that burned areas should be closed to pasture for at least six years. The recovery of cedar forests may be thwarted if excessive browsing takes place within twenty years.[d]

311 139 The best-known relict of the cedars of Lebanon, a stand of several hundred trees, is protected from vandalism by a church and from goats by a stone wall.[e] In open places in the Mamora forest, young cork oaks survive only within a protective cluster of palmetto. On the semiarid plains of northeastern Morocco, *Pistacia atlantica* rarely survives unless it is protected by a spiny hedge of zizyphus or sumac (*Rhus pentaphylla*), and in the Sous Valley the latter species plays an even more vital role as a protector of young *Argania* trees. In the mountains of northern Morocco, seedlings of cedar, pine, and fir are protected by the armature of the juniper. Elsewhere on the Mediterranean versant, young trees may be protected by *Genista, Calycotome, Ulex,* and other thorny Leguminosae.

311 233 372 139 Trees that reproduce by coppice shoots are seldom completely destroyed, but excessive browsing may reduce them to shrub form. In the geographic textbooks the scrub or dwarf state of the Mediterranean woodland is often described as a consequence of the Mediterranean precipitation regime. The error of this generalization is manifest in the holly oak. That the stunted and deformed appearance of this tree results from fire-induced sprouting and browsing is evident when stately trees growing on protected sites are compared with the prevalent forms. Neither climate nor any other element of the inanimate environment can explain

[TEXT CONTINUED ON PAGE 107]

[a] Boudy, *op. cit.*, I, 616, is more emphatic: "Il est d'observation courante au Maroc, comme en Algérie, que dans tous les massifs de résineux où le parcours des moutons est intense, il n'y a pas de régénération et que ces massifs sont condamnés à disparaître à plus ou moins longue échéance."

[b] Marston Bates, "Man as an Agent in the Spread of Organisms," in Thomas, *op. cit.*, p. 798, cited in note 7. [113]

[c] Raymond Furon, "The Gentle Little Goat: Arch Despoiler of the Earth," *The Unesco Courier*, January, 1958, pp. 30–32. [113]

[d] Cf. Boudy's comment, *op. cit.*, II, 552: "Régénération de la cédraie et pâturage sont choses incompatibles." The prerequisites of recovery probably include at least three or four years of unusually heavy precipitation.

[e] W. C. Lowdermilk, "Lessons from the Old World to the Americas in Land Use," *Smithsonian Inst. Ann. Rept. 1943* (Washington, D.C., 1944), p. 416. [113]

A, [See p. 132--Analyst]

7:-Mikesell K-4,5 (1955-1957) 1961 MX3 Rif MX3
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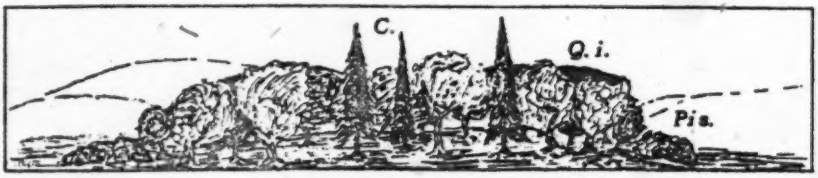

A. Sidi al-Hajj Yacub (Aith Seddath)

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B. Sidi Mahadri (near Tetuán)

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C. Km. 194, Tetuán-Melilla route

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D. Km. 55, Tangier-Larache route

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E. Bani Dercul F. Sidi Loraichi (Bani Arus)

Fig. 25. Profiles of vegetation on sacred sites.

7: Mikesell K-4,5 (1955-1957) 1961
MX3 Rif MX3
Jebala MX2
Senhaja MX4

the stunted form of this tree. The same remarks apply to dwarf forms of thuya and oleaster. On protected sites even the palmetto may become a tree and, when disturbance is manifest, dwarf forms of cedar develop.

Vegetation on Sacred Sites

Throughout Morocco and to some extent elsewhere in the Muslim world, cemeteries are regarded as sacred ground. Sanctity is ascribed also to the areas adjacent to tombs or shrines of saints (*murabitin*). The cult of saints has been an important factor in Moroccan history, and tombs or shrines are found in the territory of each tribe.[a]

Sacred sites often constitute islands of verdure. This correlation is not unique. In *The Golden Bough* Sir James Frazer describes sacred woods in many parts of the world.[b] The interesting feature of the Moroccan situation is that such groves are extraordinarily numerous and that the veneration relates to the ground in which plants grow and not to the plants themselves.[c] Protected growth is usually more dense than the growth on adjacent profane land, and the height and girth of individual plants exceed those of plants growing on unprotected land. Some species (e.g., *Pistacia lentiscus* and *Chamaerops humilis*) rarely achieve arborescent forms on unprotected sites.

The nature of the protected growth varies from a single shrub or tree to thickets and groves. Figure 25 shows the silhouettes of vegetation on a few sacred sites. These examples, selected from hundreds, illustrate the general pattern (cf. pl. 9, *a* and *b*).

Figure 25, *a*, shows a few mature cedars surrounded by a dense growth of holly oak. The prevalent vegetation in this area is a shrub formation dominated by *Cistus laurifolius*. There are no other cedars within a radius of several hundred meters, and holly oaks, apart from those on sacred sites, are in scrub form. It is evident that succession has resulted in a retrogression from cedar to oak forest and then to a sparse cover of shrubs.

Figure 25, *b*, illustrates a protected formation dominated by oleasters (cf. pl. 9, *a*). *Pistacia lentiscus* becomes prominent where oleasters are widely spaced and light reaches the ground freely. Palmetto and thuya, even more heliophilous, are confined to the edges of the protected growth. In the surrounding area the vegetation is limited to shrubs. Numerous other examples of oleaster groves fringed with pistacia and palmetto could be described. A handsome grove appears at the tomb of Sidi Manari on Cape Malabata opposite Tangier. Five groves appear on one ridge between Tangier and Tetuán. Others appear on the marine terraces between Tangier and Arcila, and on the lower slopes of the limestone mountains

[TEXT CONTINUED ON PAGE 110]

[a] E. Lévi-Provençal, "Marabout," in H. A. R. Gibb and J. H. Kramers, eds., *Shorter Encyclopaedia of Islam* (Leiden: E. J. Brill, 1953), pp. 325–326; Emile Dermenghem, *Le Culte des saints dans l'Islam maghrébin* (Paris: Gallimard, 1954); Edward Westermarck, *Ritual and Belief in Morocco* (London: Macmillan and Co., Ltd., 1926).

[b] Sir James Frazer, *The Magic Art and the Evolution of Kings* (New York: The Macmillan Co., 1935). Part I of *The Golden Bough*.

[c] J. Cola Alberich, *Cultos primitivos de Marruecos* (Madrid: Instituto de Estudios Africanos, 1954), refers to tree worship (*dendrolatría*), but the evidence he cites relates to popular ideas of the medicinal and magical qualities of plant material (leaves, seeds, acorns, etc.) and not to the sanctity of plants as such. It is possible, for example, to recognize magical qualities in pine cones and yet have no reluctance to destroy or mutilate pine trees. In Morocco the important consideration is not what qualities a plant may possess but *where* it grows.

A, [See p. 133--Analyst]

7: Mikesell K-4,5 (1955-1957) 1961 MX3 Rif MX3
Jebala MX2

south of Tetuán. There are at least a hundred oleaster groves in the area west of Ceuta and Ksar al-Kebir. In some areas oleasters mark every cemetery. Faced with this evidence, we can hardly avoid the inference that the primordial cover of the lowlands of northwestern Morocco was a woodland formation of oleaster and pistacia, and that the present cover of palmetto scrub represents degradation.

Figure 25, *c*, shows a protected stand of holly oak. The central part of the sacred grove consists of tall trees. *Pistacia lentiscus* and *Juniperus Oxycedrus* form a ring around the protected trees. Holly oaks are scattered throughout the central highlands (cf. fig. 8), but closed stands similar to the one depicted here are found only on sacred sites.

In figure 25, *d*, the evidence suggests, not a retrogression from forest species to scrub, but, rather, that two species which usually appear as shrubs, *Pistacia lentiscus* and *Chamaerops humilis*, may have an arborescent form. The density of the protected formation and the height of its components differ markedly from the scrub cover of the surrounding land.

The cluster of cork oaks shown in figure 25, *e*, is preserved in an area of extensive clearing. Most of the nearby land has been burned during the last decade. The only conspicuous plants are *Cistus monspeliensis* in fallow fields and *Nerium oleander* along stream channels. This cluster of trees gives some indication of the plant cover of the area before it was cleared, and indicates the course of regeneration (cf. pl. 9, *b*).

In figure 25, *f*, a shrine is marked by two plants, an oleaster and a fig tree. This sketch illustrates on a small scale what the others show in greater detail. Most of the area surrounding the shrine is cultivated. Fallow fields are covered with *Asphodelus microcarpus, Urginea maritima,* and palmetto. The nearest oleaster, seven kilometers away, also grows on a sacred site.

Extent of Deforestation

Trends in plant ecology, viewed in the light of human relationships, take one of two courses, improvement or deterioration. The evidence examined thus far clearly indicates deterioration. What is the magnitude of change? This question cannot be answered in detail. Change is perceived through comparison, and the only reliable source of plant data is the visible pattern of today. Figure 26 gives a synoptic view of the distribution of forest. Figure 27, the basis for comparison, shows inferred primordial or potential forests. The first map is objective; it is a cartographic record of the distribution of forest in the sixth decade of the twentieth century. The second map is subjective, and its usefulness is conditioned by the quality of the evidence presented thus far.

The details of these maps are less important than their general outlines. The implication is clear that the present wooded area constitutes only a small part of the primordial forest. Many forest species, now stunted and widely spaced, may once have been taller and more closely spaced. Under undisturbed conditions the exceptionally xerophytic or heliophilous species would probably be confined to sunny slopes in the western sector or be limited to the semiarid eastern plains. Under optimum conditions the area covered by pyrophytic shrubs would be greatly reduced, and there is no reason to believe that the primordial cover

7: Mikesell K-4,5 (1955-1957) 1961 MX3 Rif MX3
Senhaja MX4

would have included a large proportion of thorny plants. The exceptionally mesophytic species, *Abies pinsapo*, *Cedrus atlantica*, and *Quercus pyrenaica*, would presumably be restricted to the mountains even if all destructive activity came to an end. But moderately xerophytic and heliophilous trees, the oleaster and the evergreen oak, would occupy larger territories. Under favorable conditions the Barbary thuya would probably be taller and more closely spaced, and the formation described as thorn scrub would be a xerophytic woodland, dominated by *Pistacia atlantica* and *Rhus pentaphylla*.

If cutting, browsing, and burning ceased, most of the area now covered with palmetto scrub would eventually be clothed with forests of oleaster, cork oak, and holly oak. The primordial ranges of oleaster and cork oak would be determined by edaphic and climatic factors. The cork oak, which cannot grow on calcareous soils, would occupy the Pliocene terraces of the Atlantic littoral, the sandstone outliers of the Rif chain, and the slopes of intermediate elevation in the schistose highlands. Some connection may have existed between the cork forests of the central highlands and the small stand of *Quercus Suber* in the mountains immediately east of Wad Nkour. A solitary cork oak grows on a sacred site near the summit of Adrar Gurugú (885 meters). Recent dunes on the Atlantic and Mediterranean coasts probably were once covered with *Juniperus phoenicea*.* In heavy clay soils the cork oak would give way to *Olea europaea* and *Pistacia lentiscus*, which would cover the lower slopes of the limestone mountains also. The sacred groves west of Ceuta and Shawen exemplify the natural state of this formation.

At higher elevations in the limestone mountains the natural forest was probably dominated by holly oak. It is necessary to postulate such a forest even though there is little evidence of it today. The agents responsible for the destruction and mutilation of *Quercus Ilex* have already been described. As we have noted, this tree is tolerant of most soils and has the widest range of any Moroccan tree (fig. 7).

The natural province of the Moroccan fir would be about the same as its present range, above 1,500 meters in the limestone mountains. At present this genus is restricted to the mountains east and southeast of Shawen. The only other peak in the calcareous chain high enough to support fir forests is Jbil Kelti (1,927 meters). Destructive processes, especially browsing by goats, have reduced the density of the remaining stands, but it is not likely that fir forests covered any lowland area in historic time.

Changes of greater magnitude appear to have taken place in the cedar forests. The lower limit of this tree overlaps the upper limit of cultivation (pl. 6, *a*). Retreat is especially evident on the northern slope of Adrar Taghzut (fig. 28). At present the lower limit of the forest on this slope is at about 1,800 meters, but a single majestic cedar grows on the site of a shrine (Sidi Abd al-Grifar) in the bottom of a deep valley, 600 meters below the main stand. In the valley of Wad Ouergha, protected cedars are found at even lower elevations. In the

[TEXT CONTINUED ON PAGE 113]

* The red juniper is still scattered over the dunes between Rabat and Larache, but has been replaced by herbaceous growth and the Aleppo pine on the Mediterranean coast. On dune vegetation, see J. Ruiz de la Torre, "La vegetación natural del norte de Marruecos," *Notes Marocaines*, 9–10 (1957), 23–33; and Louis Emberger, *Notice phytogéographique sur une partie de la meseta marocaine septentrionale* (Montpellier: Causse, Graille, and Castelnau, 1931).

A, [See p. 130--Analyst]

7: Mikesell K-4,5 (1955-1957) 1961 MX3 Rif MX3

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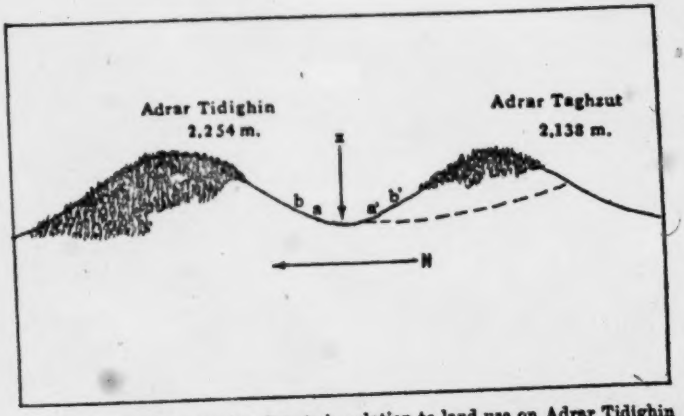

Fig. 28. Position of cedar forests in relation to land use on Adrar Tidighin and Adrar Taghzut: *a*, *a'*, zone of irrigated terraces; *b*, *b'*, zone of dry farming; *z*, location of protected cedar.

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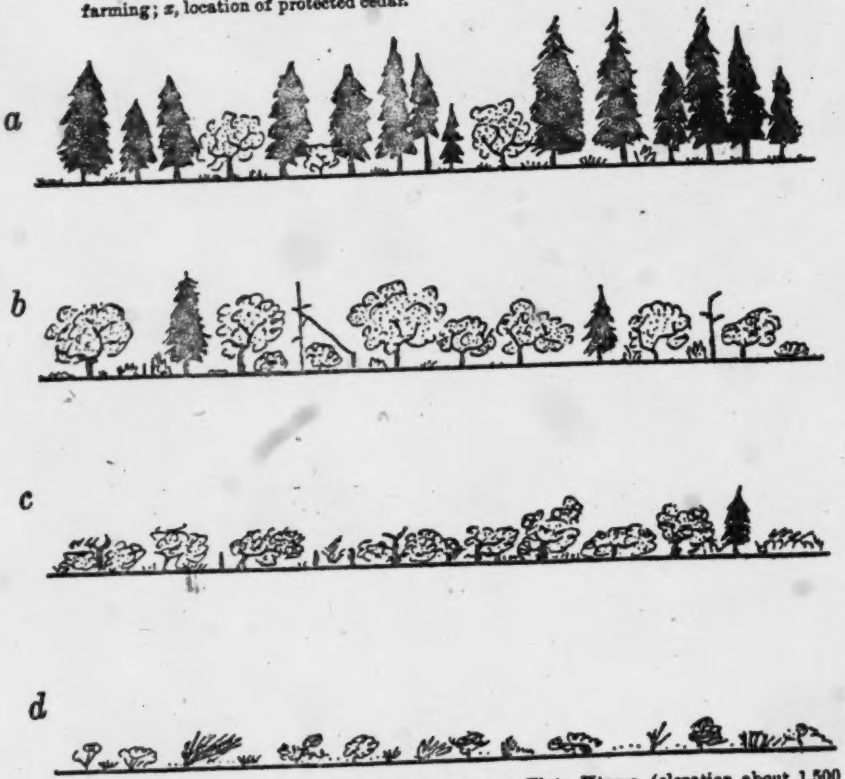

Fig. 29. Stages in retrogression of a cedar forest near Tlata Ktama (elevation about 1,500 meters): *a*, undisturbed forest; *b*, mixed stand of cedar and oak; *c*, secondary scrub oak formation; *d*, tertiary scrub formation without oak.

7: Mikesell K-4,5 (1955-1957) 1961 MX3 Rif MX3
Jebala MX2
Senhaja MX4

bottoms of valleys, low nocturnal temperatures, caused by air drainage, probably favor the cedar; nevertheless, on many slopes the forest line appears to be 300–500 meters above its natural position.

Cedar forests do not regenerate unless pasturing is suppressed and there is an opportune cycle of wet years. Moreover, the subsoil and parent material must be loose enough to favor the development of seedlings and yet compact enough to retain moisture. A further prerequisite is that there must not be a thick cover of competitive shrubs. A single deforestation may drastically upset the natural equilibrium; if disturbance continues, recovery may be impossible. The mantle of cedars on relatively inaccessible slopes gives some indication of the appearance of the primordial forest (pl. 10, *a*). Figure 29 shows the trend of retrogression. On gentle slopes, undisturbed stands are dense, dark, and relatively free of underbrush. Steeper slopes, exposed to greater insolation, have an understory of shrubs and oaks. Burning or cutting followed by pasturing eliminates the cedar and reduces the oaks to scrub form. If disturbance continues, the plant cover degenerates to a sparse scrub of *Genista quadriflora, Juniperus Oxycedrus,* and *Cistus laurifolius.*

It is difficult to delimit the primordial pattern of the cedar forests. Forests probably existed on Jbil Kelti (1,927 meters), Jbil Sugna (1,600 meters), and Jbil Buhashim (1,681 meters), for a few cedars still grow on these peaks. The absence of cedars from Jbil Khsana (1,695 meters) is puzzling, since this peak receives abundant precipitation, and is composed of sandstone and schist, which weather into deep soils. At present no cedars appear east of Adrar Tizi Ifri, but they may once have clothed the highest peaks of the eastern Rif, including Adrar Hamam (1,930 meters) and Azru Akchar (2,011 meters). It cannot be proved that the cedar once grew beyond its present range, but the pattern of succession suggests that some stands may have been completely destroyed.*

The theory was presented, in chapter ii, that both the Aleppo and the maritime pine may be relicts which have been encouraged to advance by the destruction of competitive growth. If this notion is sound, the area originally covered with pines must have been even smaller than the present stands. This interpretation helps to explain the presence of pines in degraded forests of cedar and fir. However, human interference has probably caused a reduction of some stands of Aleppo pine, particularly on the Melilla peninsula and in the mountains southeast of Shawen. Disturbance might initially have encouraged expansion and then forced a new retreat. It is difficult to enlarge on this idea, for the existing stands of pine are too small and widely scattered to be placed accurately on the maps.

Prolonged disturbance and exploitation of the Barbary thuya have diminished the density of the remaining stands and reduced many trees to shrub form. The natural range of thuya in the western half of the zone can be traced without much difficulty. At higher altitudes on the Mediterranean versant, increased precipitation and lower winter temperatures favor cork oak and holly oak. On the Atlantic versant, climatic factors alone delimit the range. It is more difficult to trace a

* Louis Emberger, *Aperçu général sur la végétation du Maroc* (Bern: Hans Huber, 1939), (ref. to map), seems to regard the primordial range of the cedar as essentially the same as the present range. Ruiz de la Torre, *El matorral en Yebala,* pp. 22–23, cited in note 41, suggests a natural extension to include the highest peaks of Ghmara and Jbala.

A, [See p. 134--Analyst]

7: Mikesell K-4,5 (1955-1957) 1961 MX3 Rif MX3

limit in the area east of Wad Nkour. Emberger believes that most of the eastern lowlands were once covered with thuya.[44] According to another study, undertaken by an engineer of the Spanish forestry service, the natural range of the thuya extended to all areas of residual soil from the Nkour Valley to Wad Moulouya.[45] These interpretations may be sound, but the evidence presented here suggests that the primordial cover of most of the eastern sector was a mixed formation of *Pistacia atlantica* and *Rhus pentaphylla* with scattered clumps of oleaster. The effect of prolonged disturbance has been to reduce the area covered by these species and to favor the expansion of alfa grass (*Stipa tenacissima*), dwarf sage (*Artemisia Herba alba*), and camel thorn (*Zizyphus lotus*).

There has been no study of plant succession in the arid and semiarid parts of northern Africa comparable in scope to Aubréville's monumental treatise on the effects of burning, clearing, and pasturing in tropical Africa.[46] Deterioration of ranges and "xerophytism" have been reported for most of the pre-Saharan zone, but it is not yet possible to determine the extent of change. The American statesman-scholar George P. Marsh argued long ago "that forests would soon cover many parts of the Arabian and African deserts, if man and domestic animals, especially the goat and camel, were banished from them."[47] In recent years a number of French scholars have expressed doubts concerning the theory that the vast formations of alfa grass and dwarf sage on the Algerian plateaus developed as a result of the semiarid climate.[48] After careful study of scattered stands of *Acacia gummifera* on the arid littoral of Morocco, south of Agadir, Charles Sauvage questions whether the zone between Anti Atlas and Wad Dra should be described as asylvatic.[49] Basing his conclusions on the wide occurrence of acacias in the desert, one author speaks of the primordial forests of the Sahara.[50] Sixty years ago another naturalist discovered that many of the wadis in the Egyptian desert were named after trees that had since disappeared.[51] Thus we have evidence that the effects of human disturbance have been felt even in the Sahara, and that aridity does not prevent the growth of some trees.

In the semiarid sector of northern Morocco it is possible to reconstruct vegetational changes with the aid of relict formations preserved on sacred sites. At the shrine of Sidi Seddic, on the border of the territories of Ulad Stut and Aith Bu Yihyi, a majestic oleaster, surrounded by sumac, is in striking contrast to the prevalent cover of dwarf sage. *Pistacia atlantica*, one of the few trees of northern Africa that can grow on heavy alluvial soils, appears on several sacred sites in

[44] Emberger, *Aperçu général sur la végétation du Maroc*, pp. 71–78.

[45] J. Ruíz de la Torre, "La vegetación natural del norte de Marruecos," *Notes Marocaines*, 9–10 (1957), 30–33.

[46] André Aubréville, *Climats, forêts et désertification de l'Afrique tropicale* (Paris: Editions Maritimes et Coloniales, 1949).

[47] George P. Marsh, *The Earth as Modified by Human Action: A Last Edition of "Man and Nature"* (New York: Scribner's Sons, 1885), p. 149.

[48] According to Emberger, *Aperçu général sur la végétation du Maroc*, p. 68, "Les prairies d'halfa peuvent représenter d'anciennes forêts de *Juniperus phoenicia*, parfois même de *Callitris* et même de *Quercus Ilex*." Buffault, "Le déboisement de l'Afrique du Nord," p. 481, cited in note 15, also accepts the notion of a primordial forest on the Hauts-Plateaux.

[49] Ch. Sauvage, "Les environs de Goulimine: carrefour botanique," in *Volume jubilaire de la Société des Sciences Naturelles du Maroc* (Rabat, 1948), pp. 107–146.

[50] L. Lavauden, "Les forêts du Sahara," *Rev. des Eaux et Forêts*, 65 (1927), 265–277.

[51] E. A. Floyer, "Disappearance of Desert Plants in Egypt," *Kew Bull. Miscell. Information*, 72 (1892).

7: Mikesell K-4,5 (1955-1957) 1961 MX3 Rif MX3

the valleys of Wad Moulouya and Wad Kert.* The Aleppo pines preserved on the Melilla peninsula tell a similar story of general destruction and rare survival. Elderly tribesmen of Ibdharsen, Aith Bu Yihyi, and Ulad Stut remember a time when great thickets of sumac covered the plains of Garet.

The evidence examined in this chapter supports the thesis, now accepted by most students of Mediterranean vegetation, that the prevalent maqui and garrigue formations are produced and maintained by man. The pattern of succession in the drier eastern sector of northern Morocco depends upon ecologic processes that are not yet thoroughly understood. The theory that this area was once wooded may or may not be sound, but there is no reason to believe that the primordial cover included a high proportion of tussock grass, zizyphus, or other animal-resistant plants. Any projection of current trends, whether in the drier or the wetter areas, suggests a large degree of change. This introduces new problems, for the inevitable result of biotic disturbance is a modification of the soil.

Erosion

The steep slopes of northern Morocco favor rapid runoff and prevent the formation of deep residual soils. Moreover, torrential rains in winter and spring follow vigorous mechanical weathering during the dry summer months. It would be hard to imagine an area more vulnerable to destructive erosion. Few slopes have an adequate plant cover, and forest now covers only about a tenth of its primordial range. In view of these natural and artificial conditions, it is not surprising that soil forms a deep and continuous mantle only in the coastal plains, and that most of the highlands are bare.

A useful point of departure is to locate areas that are virtually without soil. This is the situation in the calcareous highlands. From Jbil Musa to Ibuqquyen the horizon is dominated by a wall of bare limestone. It is possible that soil never was formed on the steepest slopes. On moderate slopes there are small and discontinuous patches of clay, but most of the calcareous zone has been stripped of fine material and only cobbles remain. Here and there are tiny mounds of soil preserved by the roots of a palmetto (pl. 11, *b*). On some slopes, particularly in the range of Jbil Kelti, lines of stone have been built up when there was enough soil to justify clearing and cultivation.

The rate of erosion in any storm depends on the force with which raindrops stir up the soil and the amount and speed of the runoff. Deforestation, particularly on steep slopes, accelerates degradation, and the combination of cutting, burning, and browsing prevents any reëstablishment of protective cover. Although the calcareous highlands were probably once covered with forests of holly oak (cf. figs. 5 and 27), today, vast areas lack even herbaceous growth. In the karstic highlands the only conspicuous plants are palmetto and spiny gorse (*Ulex parviflorus*).

Erosion is not quite so serious in the highland areas formed of schist and sandstone. Protected stands of cedar, cork, and deciduous oaks are associated with abundant litter and about eighteen inches of clay or sandy loam. But in cleared areas there is abundant evidence of loss of topsoil (pl. 10, *b*). Since it is common

* *Pistacia atlantica* has been used to stabilize slopes in Israel. G. F. Gindel, "Afforestation of the Semi-arid and Arid Areas in Palestine," *Empire Forestry Rev.*, 25 (1946), 213–221.

7: Mikesell K-4,5 (1955-1957) 1961 MX3 Rif MX3
Jebala MX2

practice to allow sheep to graze on stubble, many slopes are completely bare when the first rains fall. Erosion is retarded during spring and summer when a part of the runoff is diverted into irrigation ditches, but the irrigation systems promptly disintegrate at the beginning of the rainy season, and runoff again follows the network of gullies (pl. 11, *a*).

Gullying is most severe in the hilly areas of the Rif. The basins of Wad Ghis, Wad Nkour, and Wad Kert show an intricate pattern of short, steep slopes. "Ghis" means "mud" in Arabic, and most of the mud comes from the denuded highlands. The lower course of each river is joined by deeply entrenched tributary streams cutting through old fans and terraces. In Targist, Thimsaman, and Tafarsith the best farms are on fragments of Pliocene conglomerate, isolated from one another by deep ravines. Badland topography covers most of the area between Wad Nkour and Wad Kert. This may be described as an erosion-induced hoe-culture, for slopes are so badly dissected that it is no longer possible to use plows. The desperate effort to produce grain is abandoned only when the harvest does not repay the investment in seed. Cereals are sown in gullies and on nearly vertical slopes. The Spanish learned to their dismay that hungry Rifians try to cultivate even the roadbeds. The plains of Garet and the lower Kert constitute islands of alluvium in a sea of denuded terrain. Serious erosion becomes evident as soon as one passes to older terrace and residual soils. The hills of Ikibdhanen and the volcanic eminence of Gurugú are as bare as the limestone peaks.

The pattern of gullies and rills continues into the hills of Jbala and Ghmara, but the most serious problem in these areas is sliding. The roads from Tetuán to Tangier and Shawen are blocked by slides every year. In Anjra and Fahs one is never out of sight of a slide scar. Gullying is less serious than in the eastern sector, but streams are slightly entrenched even in the rolling country south of Tangier, and the marine terraces between Arcila and Larache are cut by deep barrancas."[113]

[113] René Raynal, "Bodenerosion in Marokko," *Wissenschaftliche Zeitschrift der Martin-Luther-Universität Halle-Wittenberg*, 5 (1956–1957), 885–894.

7: Mikesell K-4,5 (1955-1957). 1961 MX3 Rif MX3
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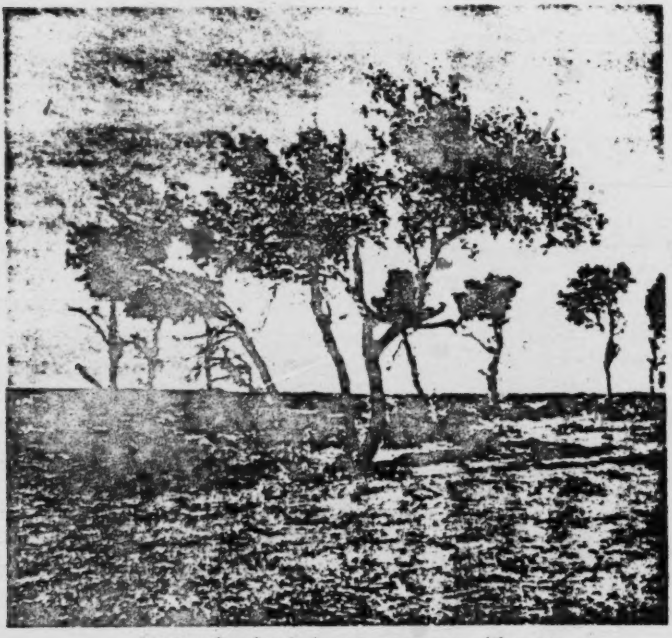

a. Mutilated cork oaks in an area overrun with goats.

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b. Jbalan woman with a load of firewood.

7: Mikesell K-4,5 (1955-1957) 1961 MX3 Rif MX3

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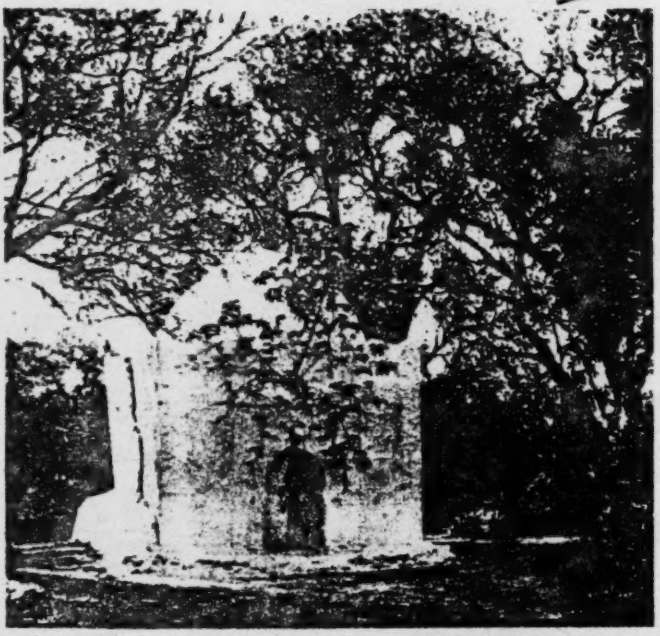

a. Protected forest at the tomb of a saint near Tetuán. Mature specimens of *Olea*, *Callitris*, and *Pistacia lentiscus*. Cf. fig. 25, *b*.

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b. Sacred clump of cork oak on the site of a shrine near Shawen. *Cistus monspeliensis* appears in foreground.